**Section 2b: The Group 7 elements — chlorine, bromine and iodine**

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| 2.5 know the colours, physical states (at room temperature) and trends in physical properties of these  elements  2.6 use knowledge of trends in Group 7 to predict the properties of other halogens  2.7 understand how displacement reactions involving halogens and halides provide evidence for the  trend in reactivity in Group 7  **2.8C explain the trend in reactivity in Group 7 in terms of electronic configurations** |

**Appearance and physical states of the halogens**

Study the trends in properties and complete the table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **element** | **colour** | **state** | **density (g/cm3)** | **melting point (in C)** |
| fluorine |  |  | 0.001696 | -219 |
| chlorine | yellow green | gas | 0.003214 | - 101 |
| bromine | red brown | liquid | 3.122 | -7.2 |
| iodine | dark grey | solid | 4.809 | 113.5 |
| astatine |  |  | 7 | 302 |

**Another family of elements**

Group 7 elements share the following properties:

1. they are all diatomic molecules i.e. F2, Cl2, Br2 and I2 , At2.
2. react with:
3. metals to form ionic compounds called salts
4. water to form acidic solutions
5. hydrogen to form hydrogen halides such as HF, HCl, HBr and HI.

**Trends within the group**

… as you go down group 7 …..

reactivity decreases; any halogen displaces a halogen ion from its salt which is lower in the group as shown by displacement reactions.

**Displacement reactions between halogens and halides (compounds with halogens)**

These are reactions between solutions of the halogens (Cl2, Br2 and I2 are only slightly soluble in water but soluble enough to make a solution) and solutions of their ionic compounds or salts or halides. To be able to analyze experimental observations the following information is needed:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| appearance of halogens dissolved in water | | appearance of halogens dissolved in hexane | | appearance of sodium halides | |
| Cl2 (aq) | colourless | Cl2 (aq) | colourless | NaCl (aq) | colourless |
| Br2 (aq) | orange | Br2 (aq) | red brown | NaBr (aq) |
| I2 (aq) | brown | I2 (aq) | purple | NaI (aq) |

Halogens prefer to be dissolved in hexane instead of water.

The table below summarises the results of a set of displacement experiments.

|  |  |  |  |
| --- | --- | --- | --- |
| **halogen** | **solutions of halogen salts (halides) to which halogen is added** | | |
| NaCl (aq)  (colourless) | NaBr (aq)  (colourless) | NaI (aq)  (colourless) |
| Cl2 (aq)  (colourless) | no colour change | colourless solution goes orange (bromine is produced) | colourless solution goes red-brown  (iodine is produced) |
| Br2 (aq)  (orange) | no colour change | no colour change | colourless solution goes red-brown  (iodine is produced) |
| I2 (aq)  (red-brown) | no colour change | no colour change | no colour change |

**Redox reactions.** The above observations indicate that the following reactions have taken place:

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| Cl2 (aq) + 2NaBr (aq) → Br2 (aq) + 2NaCl (aq)  During this reaction, the chlorine displaces the bromine. The chlorine atoms are reduced (each gains an electron) and bromide ions are oxidized (each lose an electron). This displacement reaction is also a redox reaction:  Half equations: reduction: Cl2 + 2e- → 2Cl- oxidation: 2Br- → Br2 +2e-  Ionic equation: Cl2 (aq) + 2Br- (aq) → Br2 (aq) + 2Cl- (aq) |
| Cl2 (aq) + 2NaI (aq) → I2 (aq) + 2NaCl (aq)  During this reaction, the chlorine displaces iodine. The chlorine atoms are reduced (each gain an electron) and iodide ions are oxidized (each loses an electron).  Half equations: reduction: Cl2 + 2e- → 2Cl- oxidation: 2I- → I2 +2e-  Ionic equation: Cl2 (aq) + 2I- (aq) → I2 (aq) + 2Cl- (aq) |
| Br2 (aq) + 2NaI (aq) → I2 (aq) + 2NaBr (aq)  During this reaction, the bromine displaces the iodine. The chlorine atoms are reduced (each gain an electron) and iodide ions are oxidized (each lose an electron).  Half equations: reduction: Br2 + 2e- → 2Br- oxidation: 2I- → I2 +2e-  Ionic equation: Br2 (aq) + 2I- (aq) → I2 (aq) + 2Br- (aq) |